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REPORT ON
PILOT PLANT STUDY
FOR
PHOSPHORUS REMOVAL
DUNDAS SEWAGE TREATMENT PLANT

November 1973

Underwood McLellan & Associates Limited
[illegible]

November 9, 1973

Our file no. [illegible]

Mr. G.A. Cu[illegible]ner
Town Administrator
Town of Dundas
Main Street,
Dundas, Ontario

Dear Sir,

Re: Pilot Plant Study for Phosphorus Removal on the existing sewage treatment in the Town of Dundas

We have now completed the above-noted study in accordance with the terms of reference set out in our agreement and are pleased to [illegible]

The findings [illegible] the preparation of our Pre-Design Report dated September [illegible], 1973.

The report recommends that the permanent phosphorus removal system should use alum as the main coagulant and that the installation of these facilities should coincide with the construction of the proposed plant expansion.

After you have had the opportunity of reviewing this report, we would be pleased to meet with your Council and other municipal representatives if there are any questions.

In accordance with the financial arrangements for the project, it is necessary that this report be forwarded to the Ministry of the Environment and we shall be pleased to do this on receipt of your instructions.

Yours very truly,

UNDERWOOD McLELLAN & ASSOCIATES LIMITED

H. Bruno, P. Eng.,
Manager - Eastern Region

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Underwood McLellan & Associates Limited

89 Carlingview Drive, Rexdale (Toronto), Ontario M9W 5E4 Telephone (416) 677-6651

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OUR FILE NO.

Mr. G.A. Corner
Town Administrator
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Main Street,
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Dear Sir,

Re: Pilot Plant Study for Phosphorus Removal on the existing sewage treatment in the Town of Dundas

We have now completed the above-noted study in accordance with the terms of reference set out in our agreement and are pleased to enclose ten copies of our report.

The findings of this study confirms the assumptions made in the preparation of our Pre-Design Report dated September 20, 1973.

The report recommends that the permanent nutrient removal system should use alum as the main coagulant and that the installation of these facilities should coincide with the construction of the proposed plant expansion.

After you have had the opportunity of reviewing this report, we would be pleased to meet with your Council and other municipal representatives if there are any questions.

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MB:dr
Encl.

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FOR
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NOVEMBER 1973

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INTRODUCTION

INTRODUCTION

With the satisfactory completion of the Treatability Study for Phosphorus Removal involving laboratory tests, a second phase was initiated to determine the full scale plant operational characteristics.

This report deals with this second phase. This study was sponsored by the Ministry of the Environment as described in the "Application for Rebate on Treatability Studies" dated December 13, 1962, Application No. 72/73T-29. Authorization to commence Phase 2 of the program was granted on March 19, 1973 by Mr. G.L. VanFleet, P. Eng., Special Co-ordinator for the Ministry.

The Town of Dundas instructed Underwood McLellan & Associates Limited to carry out various assignments including a Pilot Plant Study. The requirements of this study are:

a. Upon acceptance of the Interim Report by the Client and the Minister of Environment, arrange for a Pilot Plant Study to confirm the result of the Treatability Study.

b. Develop design criteria from the results of the Treatability Study and the Pilot Plant Study for use in the design of the Project.

c. Prepare and submit to the Client 10 copies of a report on the Pilot Plant Study.

We wish to thank Mr. P.J. Morris, P. Eng., Past Town Engineer, Mr. G.A. Corner, Town Administrator, Mr. R. Robertshaw, Engineering Technologist and Mr. A. Youell, Plant Superintendent, for their willing assistance on this Project. In addition, we acknowledge the assistance from various staff members of the Ministry of the Environment.

SUMMARY AND RECOMMENDATIONS

SUMMARY AND RECOMMENDATIONS

The Pilot Plant Study at the Town of Dundas Sewage Treatment Plant was carried out continuously from August 22, 1973 to October 7, 1973 inclusive. The study provided for the injection of aluminum sulphate to the aeration tank effluent at an average rate of 60 ppm based on average raw sewage flows.

The study confirmed the results of the jar tests described in the "Report on Treatability Study for Phosphorus Removal, Dundas Water Pollution Control Plant". It is noted that alum was selected as the coagulant to be utilized in the pilot plant study following consideration of the hydraulic conditions present at the plant.

It is recommended that the permanent nutrient removal system be installed with alum as the main coagulant. Also, the installation of these facilities should be coincident with the plant expansion program,with a final construction completion date as December 31, 1975.

JAR TEST STUDY

JAR TEST STUDY

A report on "Treatability Study for Phosphorus Removal, Dundas Water Pollution Control Plant" dated December 1972, was prepared following jar testing with various coagulants to determine the requirements for the full scale plant study. This report recommended the use of lime as the prime coagulant for phosphorus removal with application to the raw sewage.

These laboratory test results are shown in Table 1. The indicated coagulant concentrations are those which are required to produce an effluent with a total phosphorus concentration less than 1 ppm.

TABLE 1

JAR TEST STUDY

Point of Chemical Addition	Chemical Dosage ppm		
	Lime	Alum	Fe^{+++}
Raw Sewage	250-300	125-175	30 Approx.
Primary Effluent	150	100	20-30
Final Effluent	150	50	10

All of these tests were conducted in a laboratory and, accordingly, serve only as an indication of the treatability of the sewage without considering any constraints that may be imposed by the plant.

PILOT PLANT STUDY

PILOT PLANT STUDY

INTRODUCTION:

The second phase of the study on phosphorus removal at the sewage treatment plant included the carrying out of a full scale pilot plant study. This required the addition of coagulant chemicals to the sewage in the plant, together with a monitoring of the results.

Meetings were held with the Ministry of the Environment representatives to review the conditions existing at the plant. The objective of these meetings and the test program were to confirm the required chemical dosage, optimize the point of application and determine the suitability of the plant hydraulics to achieve an effluent with less than 1.0 ppm phosphorus.

A report on the Town of Dundas Sewage Collection System and Sewage Treatment Plant dated September 1973, by Underwood McLellan & Associates Limited, includes the conditions existing at the present plant. While the Jar Test Treatability Study indicated that lime should be the prime coagulant, due to the hydraulic limitation that exists in the present primary settling tanks, it

was decided to conduct the Pilot Plant Study using "alum". The outlet end of the aeration section was selected as the point of application.

STUDY PROCEDURES:

Quotations were requested from various equipment suppliers for the provision of a precision liquid chemical metering pump and alum storage tank. These respective items were ordered on April 25, 1973 and May 28, 1973. The quoted delivery date for the pump, which was immediate, was achieved. However, the supplier for the storage tank was unable to maintain the quoted time commitment and the tank was delivered on August 21, 1973 and placed into operation the following day. Prior to this, a 1000 gallon steel tank was obtained from the Works Department and the addition of alum to the plant was initiated on July 26, 1973. Corrosion problems with the use of the steel tank interfered with the operation of the chemical feed pump. Composite samples were collected, commencing on August 8, 1973, for analyses on Monday, Wednesday and Friday, during the test program. The analyses included determinations of the concentration of BOD, total phosphorus, soluble phosphorus and pH in the raw sewage and final effluent,

together with total and volatile solids content of the mixed liquor suspended solids and raw sludge. The study was terminated on October 7, 1973.

STUDY RESULTS AND DISCUSSION:

The results of all chemical analyses on samples collected during the study are contained in Table 2 . This data, when compared to the chemical analyses of the raw sewage to date in 1973, indicates that the plant was performing normally during the study. A plot of the raw sewage and final effluent BOD,as shown on Figure 1, indicates the respective BOD ranges to be 120 ppm to 290 ppm and 11 ppm to 30 ppm. The sewage entering the plant varies in strength considerably and has an average value of approximately 190 ppm. The average final effluent BOD approximated 22 ppm. The range in the pH of the raw sewage was 6.6 to 7.9 with an average of 7.05. Figure 2 shows that the average total phosphorus concentration in the raw sewage was 5.5 ppm (the initial test on August 8, 1973 was ignored since the value was abnormally high) of which approximately 89 percent was in the soluble form.

The period September 5 to October 5, 1973 was used for the study evaluation. This allowed over one month for

the plant to become acclimatized to the alum. The final effluent phosphorus results during this period averaged 0.86 pp, total P. of which 0.22 ppm or 26 percent was in the soluble form. Figure 3 indicates that 60 ppm alum dosage was sufficient and resulted in a 75 percent probability of achieving an effluent quality of less than 1.0 ppm. The sewage flow averaged 1.52 mgd, as shown on Figure 4, during the study which indicates that the average final settling tank loading was 400 gpd per sq.ft. The sewage flows have been corrected from the flow chart readings since the meter requires adjustment and is registering approximately 300,000 gpd. low. The sewage flow rate used in this study was determined by direct measurements of flow depth in the Parshall flume.

This hydraulic loading rate approximates 50 percent of the maximum settling rate for alum floc. Examination of the analyses of the aeration tank suspended solids and raw sludge concentrations did not indicate a significant change during the study. Additionally, the volatile portion of the solids were not changed. The changes that did occur in the raw sludge concentration were considered to be a result of plant operation techniques. It was reported, however, that the sludge appeared to be easier to pump towards the end of the study. Changes in the

raw sludge density and corresponding requirement for digester capacity can be best determined after the nutrient removal system has been operational for 6 to 12 months.

The study results indicate that an alum dosage of 60 ppm as $Al_2(SO_4)_3 \cdot 14H_2O$ is required to consistently achieve an effluent quality with a phosphorus concentration of less than 1.0 ppm. The alum injection rate was maintained at a constant rate of approximately 440 ml/min although the sewage flow rate varied between 1.3 and 1.75 mgd. throughout the study. This indicates that it is not necessary to closely proportion the alum injection to the raw sewage flow. Instead, average daily sewage flows should be utilized to determine the alum feed rate. The plant successfully maintained treatment throughout the study, during which time the sewage flows exceeded 2.0 mgd for short periods of time. The plant must be capable of treating peak sewage flows of 3.0 mgd with average daily flows of 1.5 mgd. The study indicates that a deterioration in the final effluent quality may result if the flows are significantly increased above 1.5 mgd average after the installation of the permanent nutrient removal facilities.

A change in the slope of the phosphorus probability graph, Figure 3, occurred as predicted by Figure 5 in the December 1972 report on the Treatability Study. The reason for this change in slope could not be explained.

ESTIMATED COSTS:

The existing pump and chemical storage tank would be utilized in the permanent installation of nutrient removal equipment. A permanent location for the alum storage tank would be selected adjacent to the present administration building to facilitate electric supply to the heating cables around the tank and installation of the pumping equipment inside the building. These costs have been included in the plant expansion program described in the September 1973 report.

The annual purchase cost of commercial grade liquid alum, based on present day costs and sewage flows, is estimated to be $12,000 per year or about $22.00 per million gallons of sewage. These amounts would be increased to approximately $16,000 and $29.00 when the operator's attendant costs are included. These costs apply to present day flows of approximately 1.5 m.g.d.

All of which is respectfully submitted.

Reichert

REGISTERED PROFESSIONAL ENGINEER
K. A. REICHERT
PROVINCE OF ONTARIO

DEFINITION OF TERMS

BOD	Biochemical Oxygen Demand
pH	Hydrogen Ion Content
P	Phosphorus
M.L.S.S.	Mixed Liquor Suspended Solids, Aeration Tank Suspended Solids
ppm	Parts Per Million
mgd	Million Gallons Per Day
Mil	Millilitre
Alum	Aluminum Sulphate $Al_2(SO)_3.14H_2O$

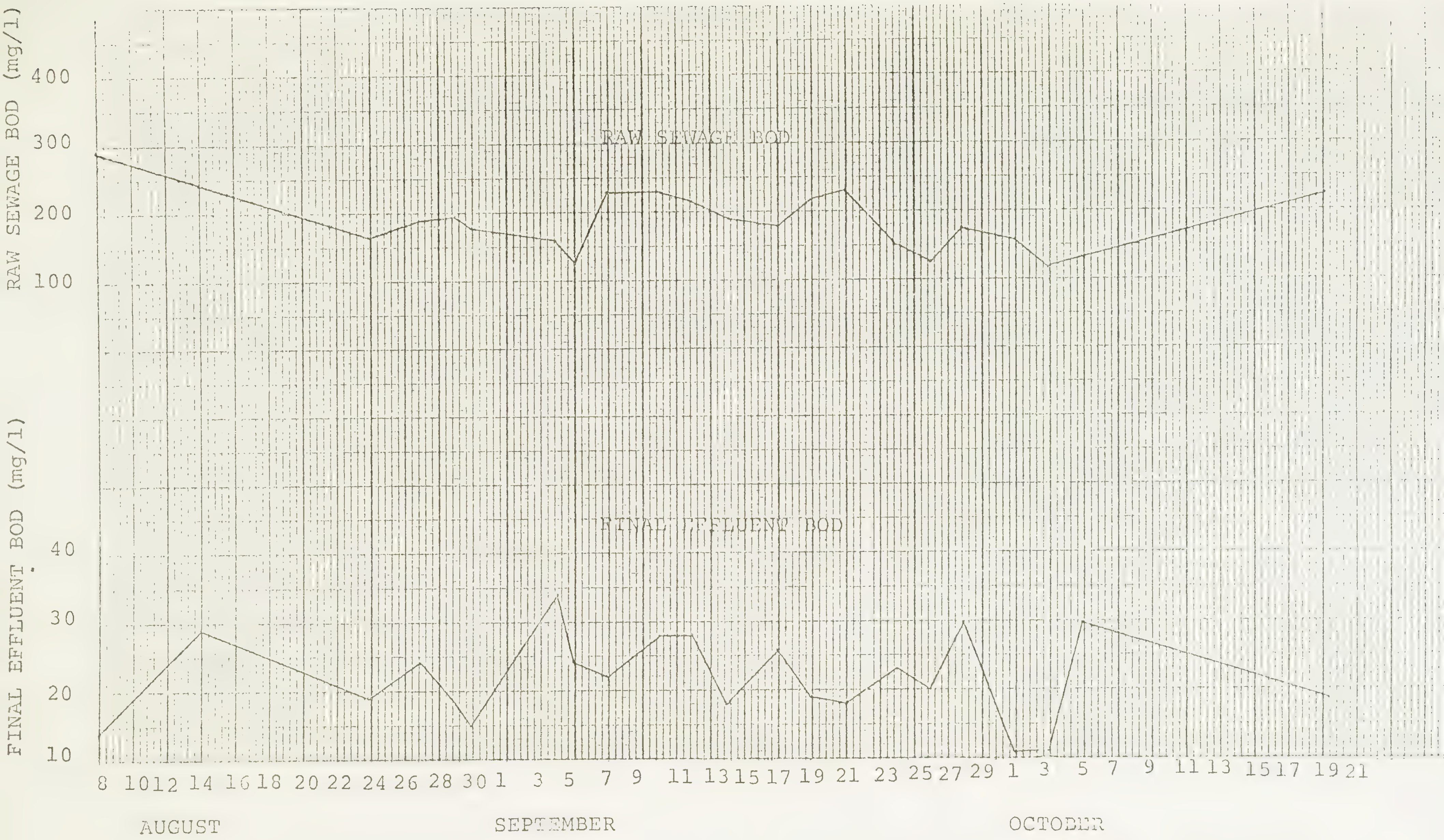
TABLE 2

DUNDAS SEWAGE TREATMENT PLANT

PILOT PLANT STUDY
TREATMENT RESULTS

	RAW SEWAGE				FINAL EFFLUENT						AERATION TANK M.L.S.S.		RAW SLUDGE % CONC.	
			Phosphorus		BOD			Phosphorus						
Date: 1973	BOD PPM	P.H.	Soluble P.P.M.	Total P.P.M.	P.P.M.	% Removed	P.H.	Soluble P.P.M.	Total P.P.M.	% Rem.	Total P.P.M	% Soluble	Total	Solub
August 8	290	7.2	3.1	39.4 *	14	95	7.0	2.6	3.4	91				
14	245	7.0	3.4	8.0	29	88	6.9	0.9	1.1	86				
24	165	6.95	4.7	5.35	19	89	6.95	1.32	1.42	74				
27	190	7.1	6.25	7.0	24	89	7.0	1.15	1.5	79				
29	195	6.95	5.3	6.1	18	91	7.0	0.80	0.95	85				
30	180	7.65	6.5	7.25	15	97	7.1	1.8	2.0	72	4850	67	2.79	69.
Sept. 4	160	7.25	5.1	5.72	34	79	7.05	2.35	2.7	53				
5	130	7.25	6.85	7.6	24	82	6.95	1.2	1.5	80	5200	65	4.79	62.
7	230	6.62	5.20	6.15	22	90	6.90	1.2	1.4	77				
10	230	7.9	6.30	7.9	28	88	7.0	0.15	0.53	93				
12	215	6.95	4.45	4.95	28	87	7.2	0.7	1.05	79			3.0	69.
14	190	7.5	4.9	5.7	18	91	6.8	0.35	0.65	89				
17	180	6.8	6.75	7.0	26	86	7.0	0.65	1.1	84				
19	220	6.6	7.15	7.9	19	91	6.8	0.35	0.65	92	5700	70	3.7	80.
21	230	7.4	6.7	7.4	18	92	7.0	0.10	0.25	97				
24	150	6.9	3.8	5.3	23	85	7.1	0.15	0.40	93				
26	125	6.7	3.6	4.2	20	84	6.9	0.10	0.20	95	5360	66.3	4.6	70.
28	175	7.2	3.25	5.85	30	83	7.0	0.10	0.30	95				
Oct. 1	160	6.8	2.7	5.3	11	93	7.0	0.25	0.55	95				
3	120	6.65	2.75	4.8	11	91	6.9	0.10	0.20	96	4100	65	1.97	69.
5	135	6.7	4.2	5.05	30	78	6.9	0.10	0.25	99				
17	225	7.1	3.7	4.4	19	92	7.0	4.15	4.45	0	4690	69	3.98	73.
Average	188	7.0	4.9	5.86	22		7.0	0.22	0.86					

* Result Discarded



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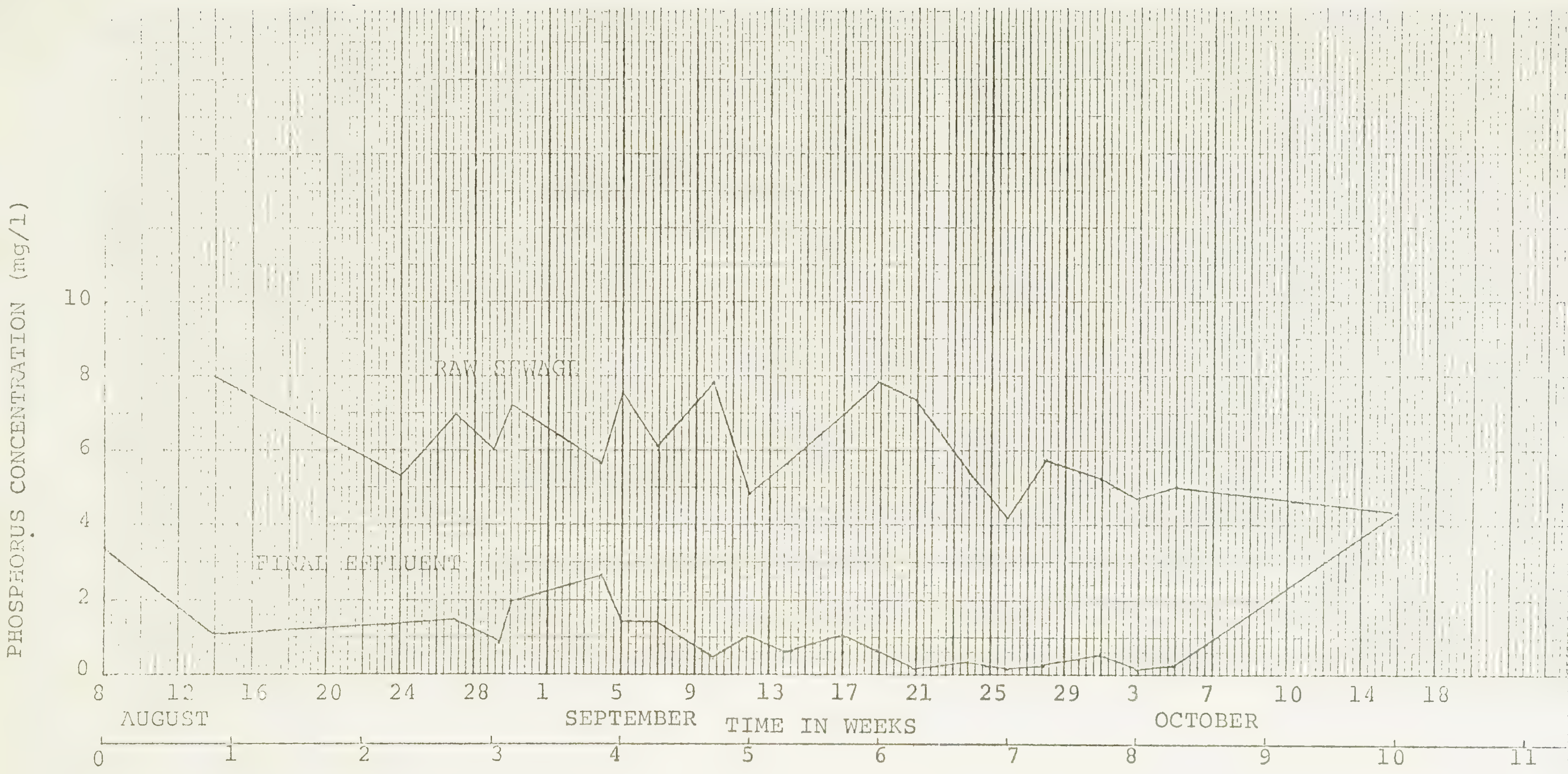
Dundas S.T.P.
Pilot Plant Study
Nov. 1973

FIG 1



RAW SEWAGE AND FINAL EFFLUENT PHOSPHORUS CONTENT

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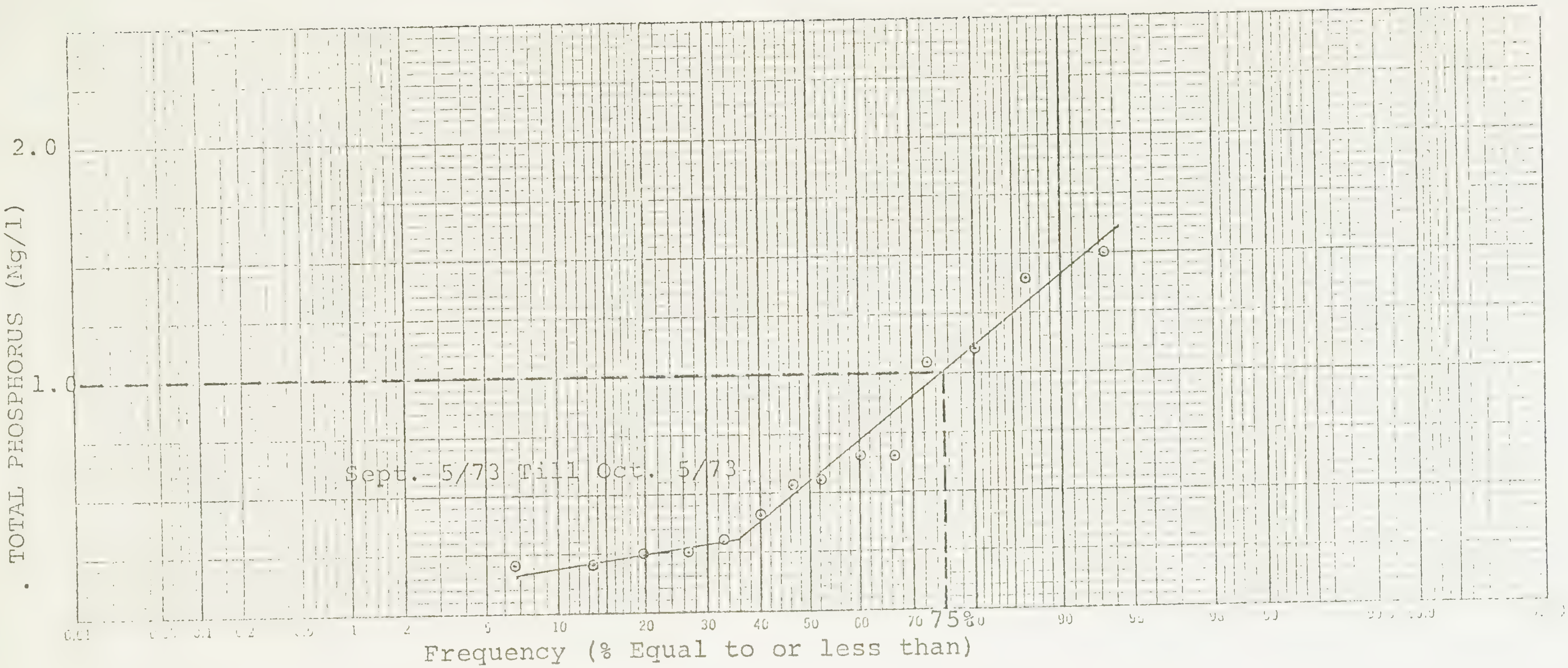
FIG 2



PHOSPHORUS PROBABILITY OCURRENCE IN FINAL EFFLUENT
WITH ALUM DOSAGE OF 60 (ppm)

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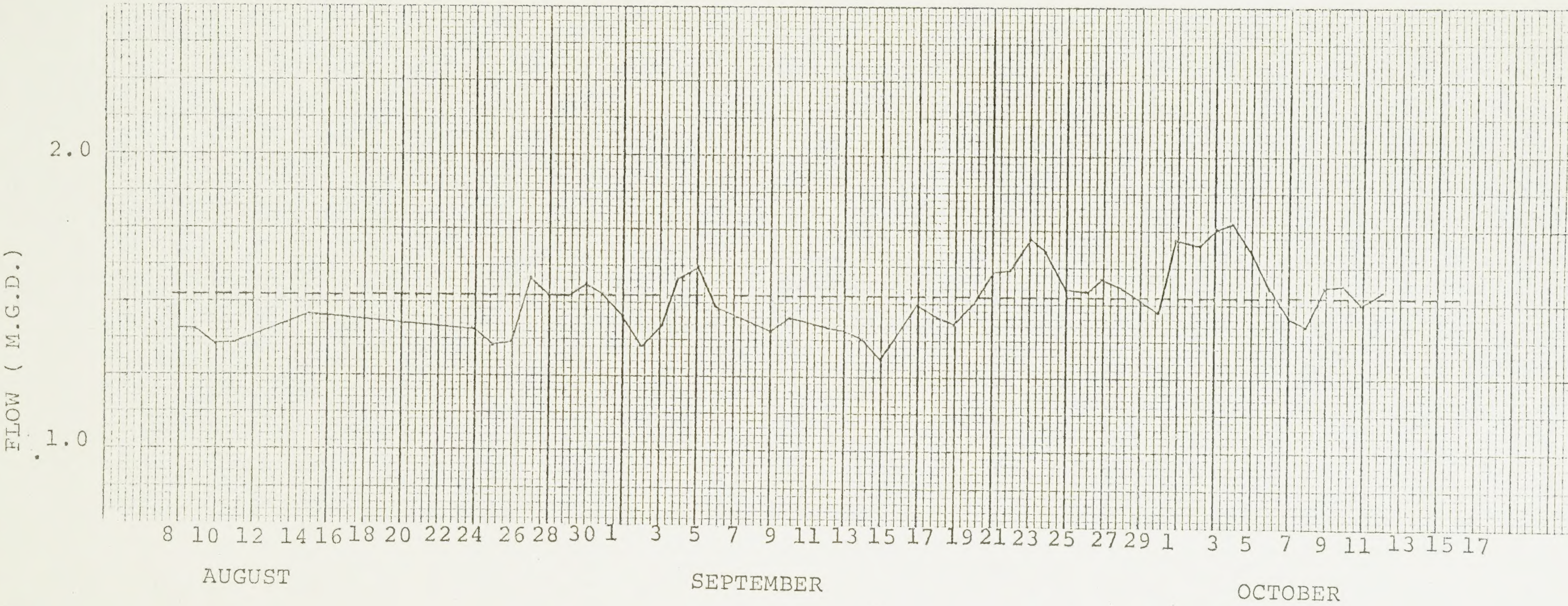
Nov. 1973

FIG 3



SEWAGE FLOWS

FIG 4

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